General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

Q.1	If '→' denotes increasing order of intensity, then the meaning of the words [drizzle → rain → downpour] is analogous to [_______ → quarrel → feud]. Which one of the given options is appropriate to fill the blank?
(A)	bicker
(B)	bog
(C)	dither
(D)	dodge

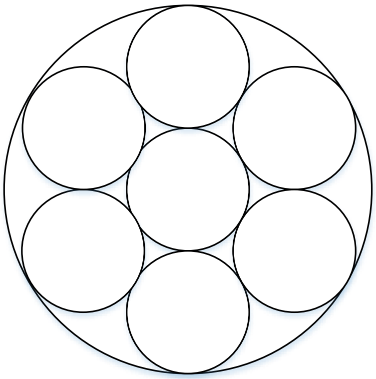
Q.2	Statements: 1. All heroes are winners. 2. All winners are lucky people. Inferences: I. All lucky people are heroes. II. Some lucky people are heroes. III. Some winners are heroes. Which of the above inferences can be logically deduced from statements 1 and 2?
(A)	Only I and II
(B)	Only II and III
(C)	Only I and III
(D)	Only III

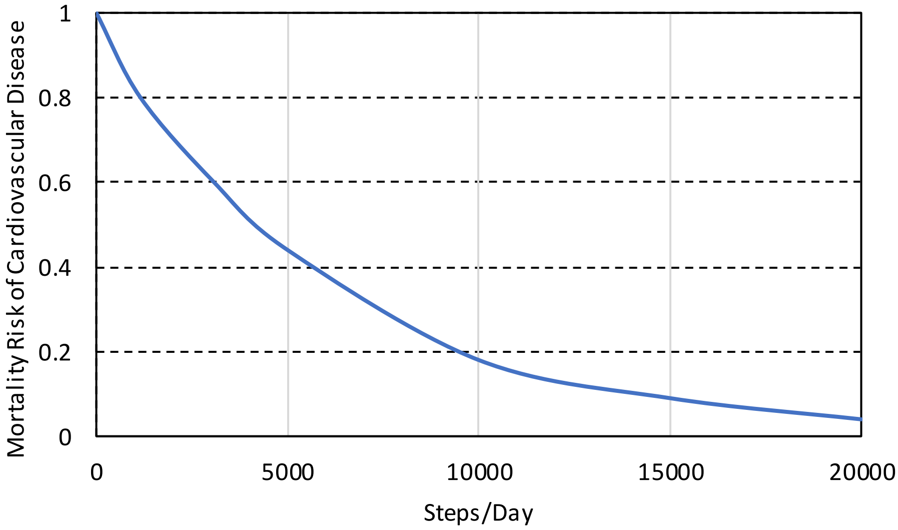
Q.3	A student was supposed to **multiply** a positive real number p with another positive real number q. Instead, the student **divided** p by q. If the percentage error in the student's answer is 80%, the value of q is
(A)	5
(B)	$\sqrt{2}$
(C)	2
(D)	$\sqrt{5}$
Q.4	If the sum of the first 20 consecutive positive odd numbers is divided by 20^2, the result is
(A)	1
(B)	20
(C)	2
(D)	1/2

Q.5	The ratio of the number of girls to boys in class VIII is the same as the ratio of the number of boys to girls in class IX. The total number of students (boys and girls) in classes VIII and IX is 450 and 360, respectively. If the number of girls in classes VIII and IX is the same, then the number of girls in each class is
(A)	150
(B)	200
(C)	250
(D)	175

Q.6 – Q.10 Carry TWO marks Each

Q.6	In the given text, the blanks are numbered (i)−(iv). Select the best match for all the blanks. Yoko Roi stands ___(i)___ as an author for standing ___(ii)___ as an honorary fellow, after she stood ___(iii)___ her writings that stand ___(iv)___ the freedom of speech.
(A)	(i) out (ii) down (iii) in (iv) for
(B)	(i) down (ii) out (iii) by (iv) in
(C)	(i) down (ii) out (iii) for (iv) in
(D)	(i) out (ii) down (iii) by (iv) for

Q.7	Seven identical cylindrical chalk-sticks are fitted tightly in a cylindrical container. The figure below shows the arrangement of the chalk-sticks inside the cylinder.  The length of the container is equal to the length of the chalk-sticks. The ratio of the occupied space to the empty space of the container is
(A)	5/2
(B)	7/2
(C)	9/2
(D)	3

Q.8	The plot below shows the relationship between the mortality risk of cardiovascular disease and the number of steps a person walks per day. Based on the data, which one of the following options is true? 
(A)	The risk reduction on increasing the steps/day from 0 to 10000 is less than the risk reduction on increasing the steps/day from 10000 to 20000.
(B)	The risk reduction on increasing the steps/day from 0 to 5000 is less than the risk reduction on increasing the steps/day from 15000 to 20000.
(C)	For any 5000 increment in steps/day the largest risk reduction occurs on going from 0 to 5000.
(D)	For any 5000 increment in steps/day the largest risk reduction occurs on going from 15000 to 20000.

Q.9	Five cubes of identical size and another smaller cube are assembled as shown in Figure A. If viewed from direction X, the planar image of the assembly appears as Figure B.

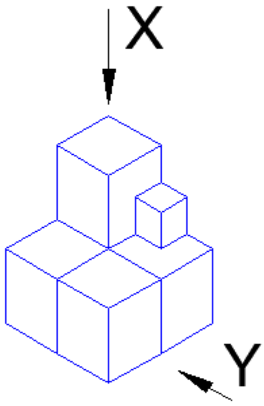


Figure A

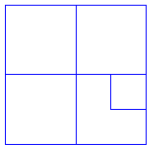
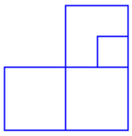


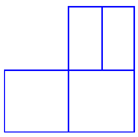
Figure B

If viewed from direction Y, the planar image of the assembly (Figure A) will appear as

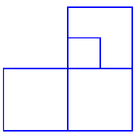
(A)



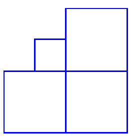
(B)



(C)



(D)



Q.10	Visualize a cube that is held with one of the four body diagonals aligned to the vertical axis. Rotate the cube about this axis such that its view remains unchanged. The magnitude of the minimum angle of rotation is
(A)	120°
(B)	60°
(C)	90°
(D)	180°

Q.11 – Q.35 Carry ONE mark Each

Q.11	A complex number is defined as $z = x + iy$ with $i = \sqrt{-1}$. $\bar{z}$ is the complex conjugate of z. The imaginary part of $(2z + 4\bar{z} + 4iy)$ is ____________.
(A)	6
(B)	2
(C)	$2y$
(D)	$3y$
Q.12	The solution of the initial value problem given by $y'' + y' - 2y = 0; y(0) = 3, y'(0) = 6$ is
(A)	$4e^{x} + e^{-2x}$
(B)	$4e^{x} - e^{-2x}$
(C)	$4e^{x} + 3e^{-2x}$
(D)	$4e^{-2x} - 3e^{x}$

Q.13	Absolute open flow potential of a well is the
(A)	maximum theoretical flow rate of reservoir fluid that a well can deliver.
(B)	minimum theoretical flow rate of reservoir fluid that a well can deliver.
(C)	flow rate of reservoir fluid from a well when the sandface pressure is 100 psia.
(D)	minimum flow rate of reservoir fluid when a well is stimulated.

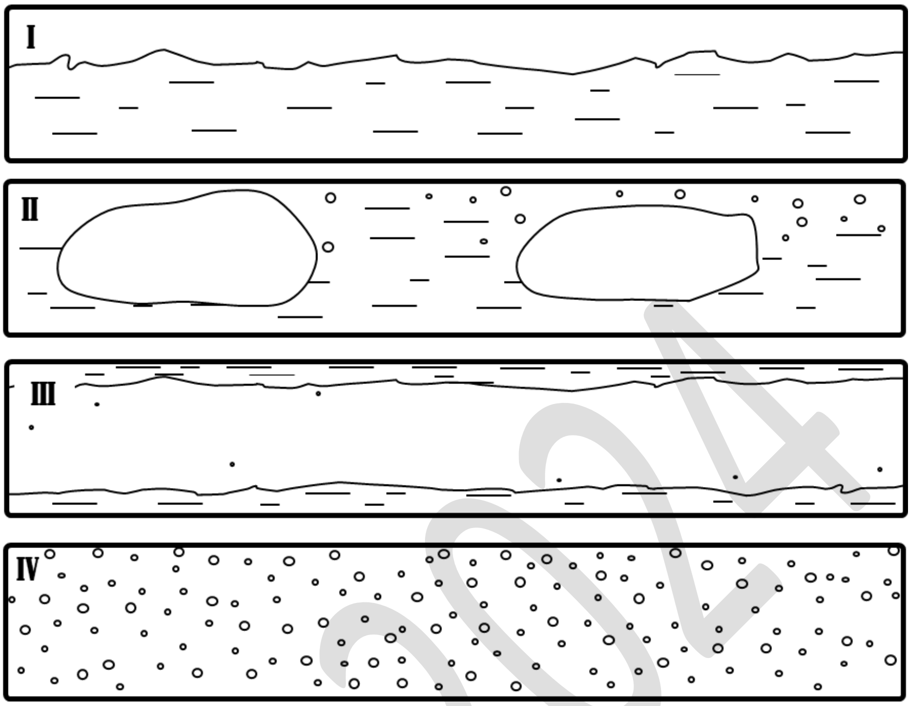
Q.14 A constant composition expansion (CCE) test is conducted on a slightly compressible reservoir fluid sample in a pressure-volume-temperature (PVT) cell at 130 °F. The data on the relative fluid volume $\left(\frac{V}{V_{sat}}\right)$ with pressure is given in the table below. V is the total volume of the reservoir fluid in the cell at a given pressure condition, and V_{sat} is the total volume of the reservoir fluid in the cell at the saturation pressure.

Pressure (in psia)	**Relative fluid volume,** $\left(\frac{V}{V_{sat}}\right)$
2530	0.967
1650	0.987
1425	0.992
1250	1.000
1128	1.021
1095	1.038

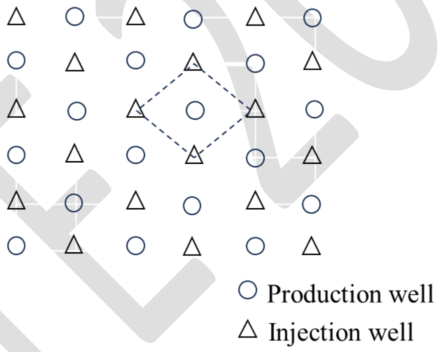
The bubble point pressure (psia) of the reservoir fluid is

(A)	2530
(B)	1650
(C)	1250
(D)	1095

Q.15	Marsh funnel viscosity is reported as number of seconds required for one quart of drilling fluid sample to flow out of a Marsh funnel. The time of efflux of one quart of fresh water from a Marsh funnel at 70±5 °F is ________ seconds.
(A)	21±0.5
(B)	26±0.5
(C)	31±0.5
(D)	36±0.5
Q.16	From the options given below, identify the process through which coal bed methane is produced.
(A)	Underground coal gasification
(B)	Open cast mining of coal
(C)	Depressurization, using vertical / horizontal wells
(D)	Underground coal combustion

Q.17	Gas-liquid flow regimes for horizontal pipelines are shown below. Identify the correct pair from the list given below. 
(A)	I – Stratified; II – Slug; III – Annular; IV – Bubbly
(B)	I – Slug; II – Bubbly; III – Annular; IV – Stratified
(C)	I – Annular; II – Slug; III – Stratified; IV- Bubbly
(D)	I – Slug; II – Stratified; III – Bubbly; IV – Annular

Q.18	The speed of Tsunami is a function of
(A)	only water depth.
(B)	only wave height.
(C)	both water depth and wave height.
(D)	both wind speed and wave height.
Q.19	Which ONE of the following is a POSITIVELY BUOYANT floating structure?
(A)	Jacket Platform
(B)	Semi-Submersible
(C)	Tension Leg Platform
(D)	Barge
Q.20	Which ONE of the following methods makes use of the centrifugal force for measuring the interfacial tension between two immiscible phases?
(A)	Pendant drop method
(B)	Spinning drop method
(C)	Du Noüy ring method
(D)	Wilhelmy plate method

Q.21	Which ONE of the following can result in a negative value of skin factor near the wellbore?
(A)	Hydraulic fracturing
(B)	Fines migration
(C)	Asphaltene deposition
(D)	Clay swelling
Q.22	For a schematically shown five-spot pattern below, what is the ratio of number of production wells to the number of injection wells? 
(A)	2
(B)	1
(C)	$\frac{1}{4}$
(D)	$\frac{1}{2}$

Q.23	Which ONE of the following options represents the waves generated during partitioning of acoustic energy at an interface inside the Earth?
(A)	Rayleigh waves
(B)	Love waves
(C)	Body waves
(D)	Surface waves
Q.24	"Earth is a low-pass filter". This implies it filters out which ONE of the following parameters in the subsurface?
(A)	Phase
(B)	Amplitude
(C)	Frequency
(D)	Velocity

Q.25	Which ONE is the correct formula for calculation of Foldage of a 2D seismic line?
(A)	$\text{Foldage} = \left(\frac{1}{2}\right)(\text{number of geophones})\left(\frac{\text{geophone interval spacing}}{\text{shot interval spacing}}\right)$
(B)	$\text{Foldage} = \left(\frac{1}{2}\right)(\text{number of geophones})\left(\frac{\text{shot interval spacing}}{\text{geophone interval spacing}}\right)$
(C)	$\text{Foldage} = \left(\frac{1}{2}\right)(\text{number of shots})\left(\frac{\text{shot interval spacing}}{\text{geophone interval spacing}}\right)$
(D)	$\text{Foldage} = \left(\frac{1}{2}\right)(\text{number of shots})\left(\frac{\text{geophone interval spacing}}{\text{shot interval spacing}}\right)$
Q.26	Well tests can be classified as either ‘single well productivity test’ or ‘descriptive reservoir test’. Which ONE of the following CANNOT be determined from a ‘single well productivity test’?
(A)	Characteristics of the formation damage and other source of skin
(B)	Well deliverability
(C)	Characteristics of both vertical and horizontal reservoir heterogeneity
(D)	Identification of produced fluids and their respective volume ratios

Q.27	Which mud type will have the highest acoustic velocity from the following options?
(A)	Mud with live oil at low temperature
(B)	Mud with dead oil at high temperature
(C)	Mud with live oil at high temperature
(D)	Mud with dead oil at low temperature
Q.28	For the given matrix $Q = \begin{bmatrix} \frac{1}{\sqrt{2}} & 0 & \frac{1}{\sqrt{2}} \\ 0 & 1 & 0 \\ -\frac{1}{\sqrt{2}} & 0 & \frac{1}{\sqrt{2}} \end{bmatrix}$, which of the following statements is/are true?
(A)	Q is an orthogonal matrix
(B)	$Q^T = Q^{-1}$
(C)	Q is a singular matrix
(D)	Q is a symmetric matrix

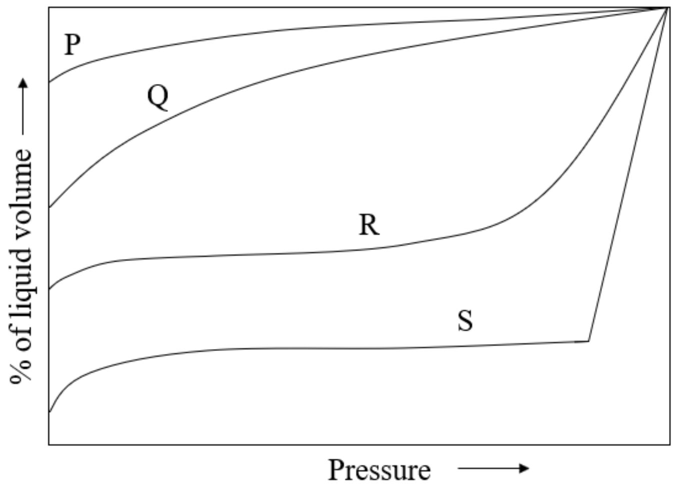
Q.29	Which of the following is/are thermal enhanced oil recovery method(s)?
(A)	Alkali-surfactant-polymer flooding
(B)	In situ combustion
(C)	Steam assisted gravity drainage
(D)	Low salinity water flooding
Q.30	Dilute sodium hydroxide is used in oilfield operations for enhanced oil recovery. For economic reasons, sodium hydroxide is delivered on site as anhydrous solid beads/cakes. This compound must be diluted on site by mixing water. Which of the following precautions must be followed during handling and preparation of dilute sodium hydroxide?
(A)	Use of Personal Protective Equipment (PPE) while handling and processing sodium hydroxide
(B)	Adequate ventilation to avoid exposure of sodium hydroxide aerosols
(C)	Stable supply of hot utility line as sodium hydroxide dilution is an endothermic reaction
(D)	Stable supply of cold utility line as sodium hydroxide dilution is an exothermic reaction

Q.31	If $P = \begin{bmatrix} 2 & -1 \\ 2 & 2 \end{bmatrix}$, the product of the eigenvalues of P is __________.
Q.32	The number of ways in which a supervisor can choose four workers out of 10 equally competent workers is _________.
Q.33	A field rotational viscometer containing a drilling fluid gives a dial reading of 12° and 20° at rotor speeds of 300 rpm and 600 rpm, respectively. The drilling fluid is assumed to obey power law model, $\tau = K\dot{\gamma}^n$, where, τ is the shear stress, $\dot{\gamma}$ is the shear rate, K is the consistency index and n is the power law index. The power law index, n, is___________ (**round off to two decimal places**).
Q.34	Shear wave velocity (V_s) in a limestone formation is 3600 m/s. Assume that the modulus of incompressibility (K) is twice that of the modulus of rigidity (G), and the bulk density (ρ_b) of the formation is 2700 kg/m^3. For this limestone formation, the compressional wave velocity (V_p) is _________ m/s.
Q.35	Two reservoir sands A and B of same thickness are encountered in a well at different depths. The hydrocarbon in the shallow reservoir sand A is 10 °API whereas, in the deeper reservoir sand B, it is 20 °API. For single phase incompressible systems, it may be assumed that the permeability in the deeper reservoir sand B is half of that of the shallow reservoir sand A, and the viscosity is directly proportional to the specific gravity of oil in respective sands. The ratio of the mobility in reservoir sand A to that of reservoir sand B is __________ (**round off to two decimal places**).

Q.36 – Q.65 Carry TWO marks Each

Q.36	Which ONE of the following is the implicit form of the solution for the differential equation given below? $\frac{dy}{dx}+\frac{(2x+3y)}{(3x+5y)}=0.$ Note: C in the options below is the integration constant.
(A)	$x^2-3xy-\frac{5y^2}{2}-C=0$
(B)	$x^2-3xy+\frac{5y^2}{2}-C=0$
(C)	$x^2+3xy-\frac{5y^2}{2}-C=0$
(D)	$x^2+3xy+\frac{5y^2}{2}-C=0$
Q.37	$\boldsymbol{r}(t)=\frac{\sin 3t}{t}\boldsymbol{i}+(t+2)^4\boldsymbol{j}+(t+1)\frac{\sin t}{t}\boldsymbol{k}$, with $\boldsymbol{i}$, $\boldsymbol{j}$, and $\boldsymbol{k}$ being the unit vectors along x, y and z directions, respectively. The value of $\lim_{t\to 0}\boldsymbol{r}(t)$ is ___________.
(A)	0
(B)	$\boldsymbol{i}+32\boldsymbol{j}-\boldsymbol{k}$
(C)	$3\boldsymbol{i}+16\boldsymbol{j}+\boldsymbol{k}$
(D)	$3\boldsymbol{i}+16\boldsymbol{j}$

Q.38 From the following figure, match the CORRECT set of liquid shrinkage curves from **GROUP I** with various crude oil systems from **GROUP II**.



GROUP I	GROUP II
(P) Curve P	(I) High shrinkage crude oil
(Q) Curve Q	(II) Low shrinkage crude oil
(R) Curve R	(III) Ordinary black oil
(S) Curve S	(IV) Near-critical crude oil

(A) P – I; Q – II; R – III; S – IV

(B) P – I; Q – III; R – IV; S – II

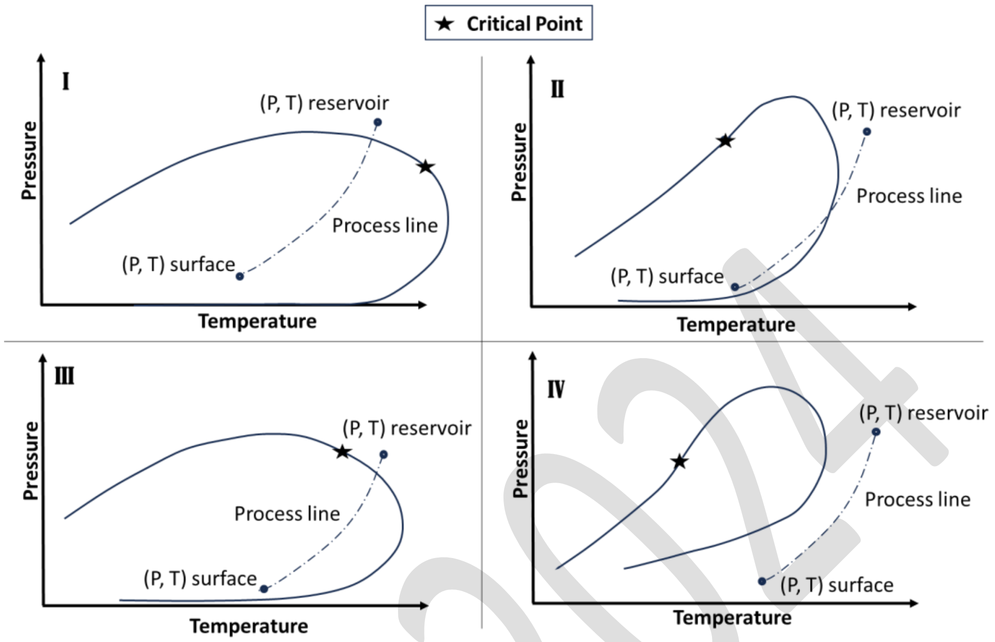
(C) P – II; Q – III; R – I; S – IV

(D) P – II; Q – IV; R – I; S – III

Q.39	Match the following pressure-volume-temperature (PVT) studies from **GROUP I** with their objectives from **GROUP II**.

GROUP I	GROUP II
(P) Constant composition expansion	(I) to determine the minimum miscibility pressure for gas injection
(Q) Differential liberation	(II) to determine the saturation pressure of the crude oil
(R) Separator test	(III) to mimic the reservoir performance during production
(S) Slim tube experiment	(IV) to design and optimize the separator conditions

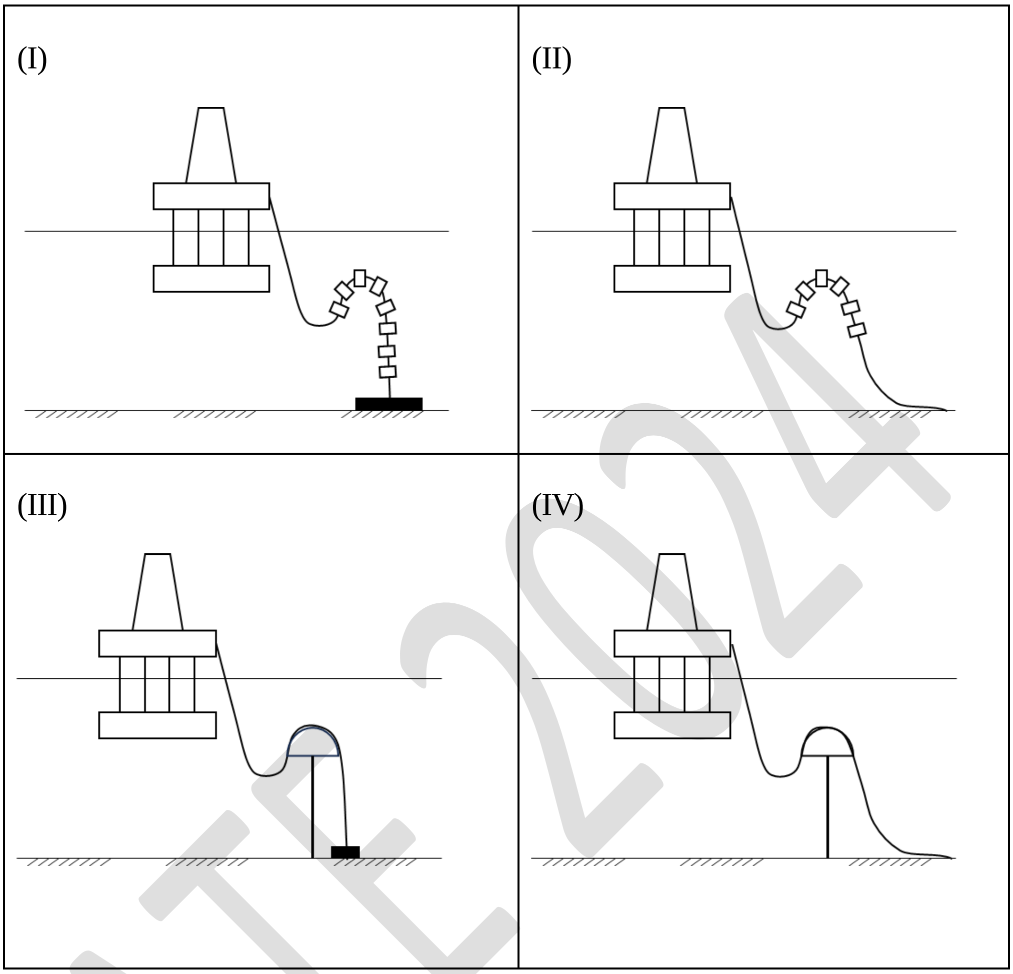
(A)	P – III; Q – II; R – IV; S – I
(B)	P – III; Q – IV; R – I; S – II
(C)	P – II; Q – I; R – IV; S – III
(D)	P – II; Q – III; R – IV; S – I

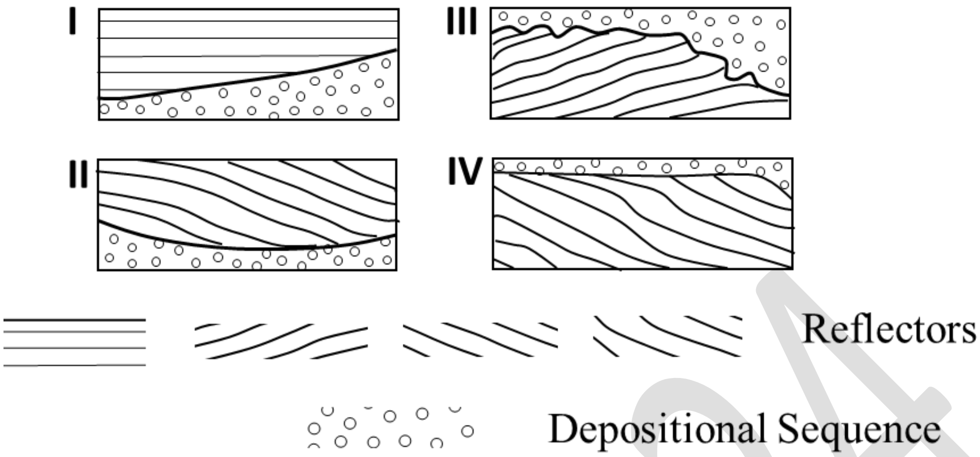
Q.40	Hydrocarbon fluids usually are classified as dry gas, wet gas, gas condensate and black oil. Which ONE of the following combinations is the CORRECT pressure – temperature phase diagram that represents the reservoir fluid type? 
(A)	I – dry gas; II – wet gas; III – gas condensate; IV – black oil
(B)	I – dry gas; II – gas condensate; III – wet gas; IV – black oil
(C)	I – black oil; II – wet gas; III – gas condensate; IV – dry gas
(D)	I – gas condensate; II – black oil; III – wet gas; IV – dry gas

Q.41	Which ONE of the following is the CORRECT combination?

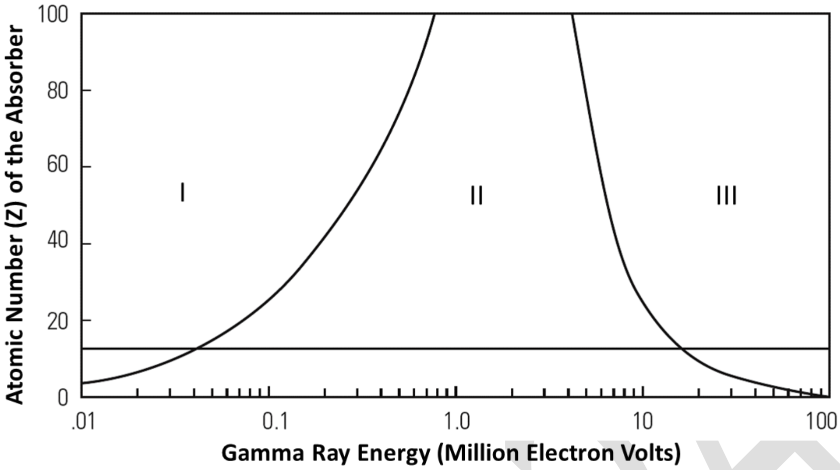
Dimensionless Number	**Ratio of the forces**
(P) Froude Number	(I) Inertia/Gravity
(Q) Capillary Number	(II) Buoyancy/Capillary
(R) Reynolds Number	(III) Inertia/Viscous
(S) Bond Number	(IV) Viscous/Capillary

(A)	P – I; Q – IV; R – II; S – III
(B)	P – II; Q – IV; R – III; S – I
(C)	P – I; Q – IV; R – III; S – II
(D)	P – I; Q – III; R – II; S – IV

Q.42	From the standard flexible riser configurations shown schematically in the figure, choose the CORRECT combination. 
(A)	I – Steep Wave; II – Lazy Wave; III – Steep **S**; IV – Lazy **S**
(B)	I – Lazy Wave; II – Steep Wave; III – Lazy **S**; IV – Steep **S**
(C)	I – Tethered Wave; II – Tethered **S**; III – Steep **S**; IV – Lazy **S**
(D)	I – Steep Wave; II – Lazy Wave; III – Tethered **S**; IV – Tethered Wave

Q.43	The figures below show the typical geometry of the subsurface strata in relation to the boundaries of the depositional sequences.  Which ONE of the following options CORRECTLY represents the four seismic sequences with their corresponding names?
(A)	I – Onlap; II –Toplap; III – Erosional truncation; IV – Downlap
(B)	I – Onlap; II – Downlap; III – Erosional truncation; IV – Toplap
(C)	I – Erosional truncation; II – Toplap; III – Onlap; IV – Downlap
(D)	I – Erosional truncation; II – Downlap; III – Onlap; IV – Toplap

Q.44	Which of the following tests is/are used to obtain reservoir deliverability (kh/μ) information? 1. Exploration or appraisal well openhole wireline 2. Exploration or appraisal well Drill Stem Test (DST) 3. Development well openhole wireline 4. Development well Drill Stem Test (DST) k: permeability, h: thickness of formation, μ: viscosity of the oil
(A)	1 only
(B)	3 only
(C)	1 and 3
(D)	2 and 4

Q.45	The decay of Gamma ray energy in the Earth formation goes through three dominant processes represented by regions I, II, and III in the figure below.  Which ONE of the following options is CORRECT?
(A)	I – Photoelectric effect; II – Pair production effect; III – Compton effect
(B)	I – Epithermal effect; II – Pair production effect; III – Photoelectric effect
(C)	I – Photoelectric effect; II – Compton effect; III – Pair production effect
(D)	I – Epithermal effect; II – Photoelectric effect; III – Compton effect

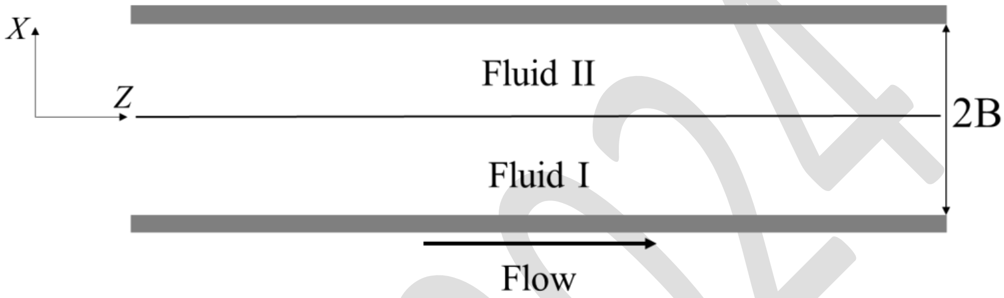
Q.46	Consider single-phase radial flow of a fluid with constant viscosity and low compressibility through a homogenous and isotropic reservoir of constant porosity, permeability, and thickness. Match the flow regime with the CORRECT mathematical relation given in the table. P represents pressure, r represents the radial coordinate, and t represents time. $f(r,t)$ is a function of 'r' and 't'.

Flow regime	Mathematical relation
(P) Steady-state flow	(I) $\left(\frac{\partial P}{\partial t}\right)_r = 0$
(Q) Transient flow	(II) $\left(\frac{\partial P}{\partial t}\right)_r = \text{constant}$
(R) Pseudosteady-state flow	(III) $\left(\frac{\partial P}{\partial t}\right)_r = f(r,t)$

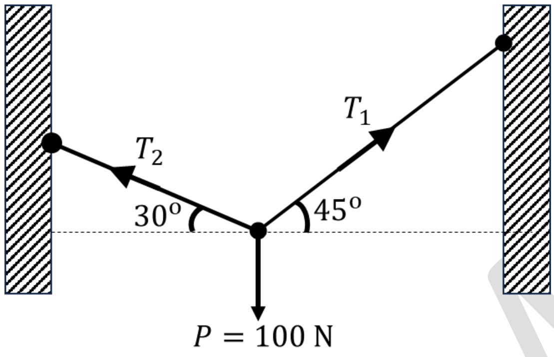
(A)	P – I; Q – II; R – III
(B)	P – I; Q – III; R – II
(C)	P – II; Q – III; R – I
(D)	P – II; Q – I; R – III

Q.47	The microbial enhanced oil recovery method helps to recover oil by which one or more of the following phenomena?
(A)	Reducing the interfacial tension due to production of biosurfactants.
(B)	Stimulating the well due to production of acids.
(C)	Increasing the mobility ratio due to production of biopolymers.
(D)	Reducing the viscosity due to production of gases in situ.
Q.48	Fixed roof tank for storage of organic liquids reduces volatile organic compound (VOC) emissions and protects the stored liquid from elements and contamination. Such tanks are generally equipped with a vent at the roof. The objective(s) of such a vent is/are to
(A)	control pressure build-up in the tank.
(B)	control vacuum generation in the tank.
(C)	add oil to the tank.
(D)	add water to the tank.

Q.49	A choke is generally installed at the well head and/or downhole. The desired function(s) of the choke is/are to
(A)	protect surface equipment from damage.
(B)	avoid sand ingress problem.
(C)	regulate production rate.
(D)	ensure oil and water coning.
Q.50	Which of the following options is/are CORRECT about the below mentioned hydrocarbons? LNG: Liquefied Natural Gas; LPG: Liquefied Petroleum Gas; NGL: Natural Gas Liquid; CNG: Compressed Natural Gas
(A)	LNG is primarily methane at approximately 110 K temperature
(B)	LPG is primarily propane and butane at standard temperature and pressure
(C)	NGL is primarily methane at standard temperature and pressure
(D)	CNG is primarily pentane at standard temperature and pressure

Q.51	Consider flow of two immiscible viscous fluids inside a thin slit of width $2B$. The flow rates of both the fluids are such that the planar interface is exactly at the center of the slit (corresponding to $X = 0$). The upper and lower fluid-solid boundaries lie at $X = B$ and $X = -B$, respectively. τ_{XZ}^{I} and τ_{XZ}^{II} are the shear stresses in fluids I and II, respectively. v_Z^I and v_Z^{II} are the velocities of fluid I and II, respectively in the Z direction. Which of the following options represent(s) the CORRECT boundary condition(s)? 
(A)	At $X = 0$, $\lvert\tau_{XZ}^{I}\rvert = \lvert\tau_{XZ}^{II}\rvert$
(B)	At $X = B$, $\tau_{XZ}^{II} = 0$
(C)	At $X = B$, $v_Z^{II} = 0$
(D)	At $X = -B$, $v_Z^{I} = 0$
Q.52	Given $f(x) = 2 + 20x + 30x^5$. The value of $\int_0^2 f(x)dx$ using **Simpson's 1/3rd rule** with only one interior point is ____________.

Q.53 If a weight of $P = 100$ N is supported by two massless strings connected to the walls as shown in the figure, the value of T_1 is ____________ N (**round off to one decimal place**).



Q.54 Porosity and oil saturation of various core samples retrieved from a layered reservoir are given below. The thickness of different layers of the reservoir is also mentioned.

Core sample	**Layer thickness, ft**	**Porosity, %**	**Oil saturation, %**
1	1.0	10	60
2	1.5	15	65
3	2.0	20	70
4	2.5	25	75

Assuming uniform area of cross section for all the layers, the average oil saturation of the reservoir is____________% (**round off to one decimal place**).

Q.55	A natural gas has the following composition.

Component (i)	**Mole fraction (y_i)**	**Molecular weight (M_i)**
CO_2	0.02	44
CH_4	0.93	16
C_2H_6	0.03	30
C_3H_8	0.02	44

Assume compressibility factor, $Z = 0.82$,

the universal gas constant, $R = 10.73 \frac{\text{psia.ft}^3}{\text{lb}-\text{mole.}^\circ\text{R}}$.

Density of the natural gas at 2000 psia and 150 °F is____________ lb/ft^3(**round off to two decimal places**).

Q.56 A surfactant enhanced oil recovery process has been employed using a five-spot injection pattern on a sandstone reservoir. The reservoir has the following properties.

Reservoir area, $A = 20$ acres

Reservoir thickness, $h = 25$ ft

Porosity of the reservoir, $\Phi = 0.20$

Residual oil saturation at the termination of waterflood, $S_{\text{orw}} = 0.30$

Residual oil saturation left by surfactant flood, $S_{\text{orc}} = 0.10$

Oil formation volume factor, $B_{\text{o}} = 1.05$ reservoir bbl/STB

Volumetric sweep efficiency, $E_{\text{v}} = 1$

The initial oil saturation of the reservoir = 0.75.

The ratio of oil displaced due to surfactant flood to the original oil in place at reservoir condition is ___________ (**round off to two decimal places**).

(Take: 1 acre = 43560 ft^2, 1 bbl = 5.615 ft^3).

Q.57	An ideal mixture of benzene and toluene is in equilibrium at a pressure of 750 mm Hg, and temperature of 90 °C. The concentration of benzene in the vapour phase in mole fraction is ________ (**round off to two decimal places**). Following data is given: $\log_{10} P_i^0 = A_i - \frac{B_i}{T + C_i}$ $A_b = 7$, $B_b = 1200$, $C_b = 210$ $A_t = 7$, $B_t = 1300$, $C_t = 210$ T is the temperature in °C. A_i, B_i and C_i are Antoine constants for component i. P_i^0 is the vapour pressure of pure component i. The subscripts, b and t, represents benzene and toluene, respectively.
Q.58	The diameter and draft of a freely floating classical upright spar without moonpool is 30 m and 75 m, respectively. The added mass in heave mode is 1.8 times the mass of the spar. The critical damping of the spar in heave mode is _______ $\times 10^6$ kg/s (**round off to one decimal place**). Take, $\pi = 3.14$. Density of seawater = 1025 kg/m^3. Acceleration due to gravity = 10 m/s^2.

Q.59	A long vertical hollow steel pipe used as a column in an offshore structure follows Euler's column theory. The length, outer diameter and thickness of the pipe are 30 m, 0.50 m, and 0.03 m, respectively. The Euler buckling load (assuming no environmental loads) of the pipe pinned at both the ends, is ________ kN (**round off to one decimal place**). Take $\pi = 3.14$. Young's modulus of elasticity for steel = 210 GPa.
Q.60	A core sample from a well-consolidated sand has a length of 10 cm, diameter of 4 cm, and a resistance (r) of 100 Ω at $T_2 = 200$ °F when completely saturated with brine. The resistivity $R_w(T_1)$ of brine is 0.5 Ω.m at $T_1 = 75$ °F. The cementation factor, $m = 2$ and the tortuosity factor, $a = 1$. Use $R_w(T_2) = R_w(T_1)\frac{(T_1+6.77)}{(T_2+6.77)}$, where T_1 and T_2 are in °F. The porosity (in fraction) of the core sample using generalized Humble's formula at 200 °F is __________________ (**round off to two decimal places**).
Q.61	In an exploratory well, both clean and dirty reservoir sand with quartz as major mineralogy is encountered. The clean reservoir sand is completely devoid of shale. The fraction of shale volume (V_{sh}) in the dirty reservoir sand is 25% with grain density (ρ_{sh}) of 2.7 g/cc. Quartz (V_q) with grain density (ρ_q) of 2.65 g/cc. The bulk density (ρ_b) of the clean and the dirty reservoir sand is 2 g/cc and 2.25 g/cc, respectively, and the pore fluid density (ρ_f) is 1 g/cc for both the sands. The difference of porosity $(\phi_{Clean} - \phi_{Dirty})$ in fraction between the two reservoir sands is_____________ (**round off three decimal places**).

Q.62	The settling velocity (v_s) of a spherical particle in a Newtonian fluid using Stokes' law is $$v_s = \frac{g d_s^2 (\rho_s - \rho_l)}{18\mu}$$ where, d_s is the particle diameter, ρ_s is the particle density, ρ_l is the drilling fluid density, μ is the drilling fluid viscosity, and g is acceleration due to gravity. The density of barite and a drilled solid particle are 4200 kg/m^3 and 2600 kg/m^3, respectively. The density of the drilling fluid is 1300 kg/m^3. The diameter of a drilled spherical solid particle that has the same settling velocity as a spherical barite particle of 0.1 mm diameter in the drilling fluid is ___________ mm (**round off to two decimal places**).
Q.63	A two-cylinder reciprocating positive-displacement mud pump is used for mud circulation. The pump can deliver fluid on both forward and backward piston strokes. The pump has the following specifications: Liner diameter = 15 cm. Piston rod diameter = 6 cm. Stroke length = 40 cm. Volumetric efficiency = 85%. Take π = 3.14. The total volume of fluid displaced per complete pump cycle is ___________ cm^3.

Q.64	Consider the displacement of oil by water through a one-dimensional homogeneous isotropic porous medium of uniform porosity, permeability and thickness. Assume oil and water to be incompressible and immiscible. The relative permeabilities of oil (k_{ro}) and water (k_{rw}) at a given water saturation (S_{w}) are, $$k_{\mathrm{ro}} = k_{\mathrm{ro}}^{0}(1 - S_{\mathrm{w}}^{*})$$ $$k_{\mathrm{rw}} = k_{\mathrm{rw}}^{0}\, S_{\mathrm{w}}^{*}$$ $$S_{\mathrm{w}}^{*} = \frac{S_{\mathrm{w}} - S_{\mathrm{wr}}}{1 - S_{\mathrm{or}} - S_{\mathrm{wr}}}$$ where, k_{ro}^{0} and k_{rw}^{0} are the end point relative permeabilities of oil and water, respectively. S_{or} and S_{wr} are the residual saturations of oil and water, respectively. Assume that $k_{\mathrm{ro}}^{0} = 0.8$, $k_{\mathrm{rw}}^{0} = 0.3$, $S_{\mathrm{or}} = 0.35$, and S_{wr} = 0.25. The viscosities of water and oil are 1 cP and 8 cP, respectively. The mobility ratio corresponding to the water saturation (S_{w}) of 0.6 is________ (**round off to one decimal place**).
Q.65	The invasion of a drilling fluid to a radius of 3 feet from the center of the well-bore into the formation has resulted in the development of skin. The permeability of the skin zone (region affected by the drilling fluid invasion) is 50 mD. The permeability of the unaffected formation is 400 mD. The well bore radius is 0.25 feet. The value of the skin factor is_______________ **(round off to two decimal places)**.